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OBSERVATIONS ON THE LIFE-HISTORY OF *EUPHORUS PALLIPES* (CURTIS) (HYM.: BRACONIDAE), A PARASITE OF HEMIPTERA–HETEROPTERA

By Maud D. Brindley, F.R.E.S.

It is well known that some Homoptera, notably the Aphididae, are extensively parasitised by Hymenoptera. The Heteroptera are apparently less subject to this kind of attack, but in recent years, in different parts of the world, certain Braconidae have been reared from Pentatomid or Capsid bugs. These parasites all belong to the subfamily Euphorinae which has a wide geographical distribution. Most of its members oviposit either in certain lepidopterous larvae or else in adult beetles belonging to various families, Coccinellidae, Tenebrionidae, Curculionidae, etc., and thus may be of considerable economic importance. However, the host associations of a great many of the group are still unknown.

The first recorded instance of the rearing of a Hymenopteron from a Heteropteron is that of Menzel (1924), who observed the parasitisation of *Helopeltis antonii* Sign., the tea-bug of Java, by a Braconid said to belong to the genus *Apanteles*. Later the same writer described in considerable detail the development of *Euphorus helopeltidis* Ferrière in the same species (Menzel, 1927).

In 1926, Lean (1926) published an account of the parasitisation of the Capsid cotton pests *Helopeltis bergrothi* Reut. and *H. sanguinis* Popp. in Nigeria by *Euphorus nigricarpus* Szepl., together with some biological notes on the development of the parasite. In 1926, also, Wilkinson (1926) recorded *Euphorus sahlbergiellae* Wilkinson as a parasite of the cocoa-bug *Sahlbergiella singularis* Hagl. (Capsidae) in West Africa.

Muesebeck (1935), in his review of the subfamily Euphorinae, recorded that *Aridelus coffeae* (Brues) was reared in Kenya by R. H. Le Pelley from both nymphs and adults of the Pentatomid coffee-bug, *Antestia lineaticollis* Stål and also that *Euphorus pallipes* (Curtis) and *Euphoriana uniformis* Gahan have been reared from *Lygus* sp. (Capsidae) in the United States of America. Finally Kirkpatrick (1937) has given a detailed account of the parasitisation of *Antestia lineaticollis* in East Africa by a species of *Aridelus* (*Helorimorpha*). Thus Braconid–Heteroptera parasitisation is known to occur in Asia, Africa, and North America, but so far the records from Europe have been scanty and incomplete. For instance, Butler (1923) describes how "a footless maggot, evidently the larva of some hymenopteron," emerged from a specimen of *Calocoris fulvomaculatus* De G., shortly after the latter had been gummed to a card in his collection. Hey (1933) found a heavy infestation of Hymenopterous parasites in a population of *Lygus*, *Plagiognathus*, and *Calocoris*. The parasites did not survive pupation, but one of them, dissected from the cocoon, was identified as of the subfamily Euphorinae. Further, Dr. Ferrière informs me that *Euphorus accinctus* (Hal.) has been bred from *Lygus* sp. in Kent.

Although I had long been aware that nymphs of *Lygus* and some other Capsidae collected in the field sometimes contained the late instars of a Hymenopterous parasite, an opportunity to investigate the matter did not occur until 1936. In June of that year, a population of *Calocoris norvegicus* Reut. with an infestation of 15 or 20% was found in a field near Cambridge. For the first time I found early instars of the larva, and subsequently some pupae were successfully carried over the winter. The imagines emerged from the cocoons in May, and were identified by Dr. Ferrière as *Euphorus pallipes* (Curtis).[1] In 1938 it was possible to observe mating and oviposition in captivity by insects reared from the larvae of the previous summer, and thus obtain an outline of the life-history.

The annual cycle of *E. pallipes* may be taken to begin about the middle of May when the adult insects emerge from the cocoons. In captivity this took place about a week earlier in 1938 than in the previous year. Throughout the winter the pupae had been kept in an open shed in my garden. Each cocoon was placed in a half-inch glass cylinder, closed at one end with cellophane and at the other with muslin. The tubes stood upright in racks on a perforated zinc plate over a dish of damp moss, and in frosty weather were protected by matting. In 1938 all the insects emerged between 10th and 15th May. When supplied with syrup, they lived between two and three weeks, but their longevity under natural conditions may be greater than this. Their behaviour was sluggish, and this made them comparatively easy to handle, coupled as it was with a pronounced tendency to climb a vertical surface. This was not simple phototropism, since they climbed readily up the sides of a vessel with an opaque cover and came to rest on the underside of the latter. Probably in the field they cling to the undersurface of the leaves of the host's food-plant. Both sexes emerged from the cocoons, and all the ovipositions took place after mating. Kirkpatrick (1937) records parthenogenesis for *Aridelus* [*Helorimorpha*] *coffeae* (Brues), and this very likely occurs in *Euphorus* also; but the material available was insufficient for many experiments in this direction, and the investigation was also hampered by the inclement weather prevailing at the time that the parasites appeared, which made it difficult to obtain enough potential hosts to offer for oviposition.

The host used in this work was the Capsid *Calocoris norvegicus* Reut. This species, which is common and widely distributed, feeds on various weeds and cultivated plants. So far as is known, it hatches in spring from eggs laid the previous autumn. Butler (1923) gives the nettle and some of the Compositae as among its favourite food; but the nymphs used in the present experiments were all swept from wild mustard plants growing as weeds in a field of winter oats. By the middle of May the bugs were for the most part in the second and third instars; and their green bodies were indistinguishable from the inflorescence of the plant on which they fed. At any shock or alarm they straightway fell to the ground, or ran rapidly down the stem. In this respect their reaction was exactly the reverse of that of the parasite, which, when alarmed, always tended to climb upwards.

Nymphs of the second and third instars are usually chosen for oviposition, but sometimes an individual of the fourth instar may be attacked. In some instances ecdysis occurred after parasitisation, but in no case was the last nymphal, or of course the adult, state attained.

When a suitable host is introduced into the cage, the parasite becomes increasingly excited as she approaches it. There is none of the stealthy and elaborate precision displayed by *Aphidius* in her leisurely decimation of an aphid colony. *Euphorus* rushes at her prey at once and seizes it; and for a few seconds there is a fierce struggle during which the parasite's egg is thrust into the host's abdomen. Then the Braconid flings, or appears to fling, the bug from her so violently that it falls to the floor of the cage, while she rests quietly and cleans herself for a few minutes before looking out for another victim. Owing to the scarcity of bugs of optimum age, it was not possible to determine the maximum number of eggs laid by each female, but it was found experimentally to be not less than twelve and is probably many more.

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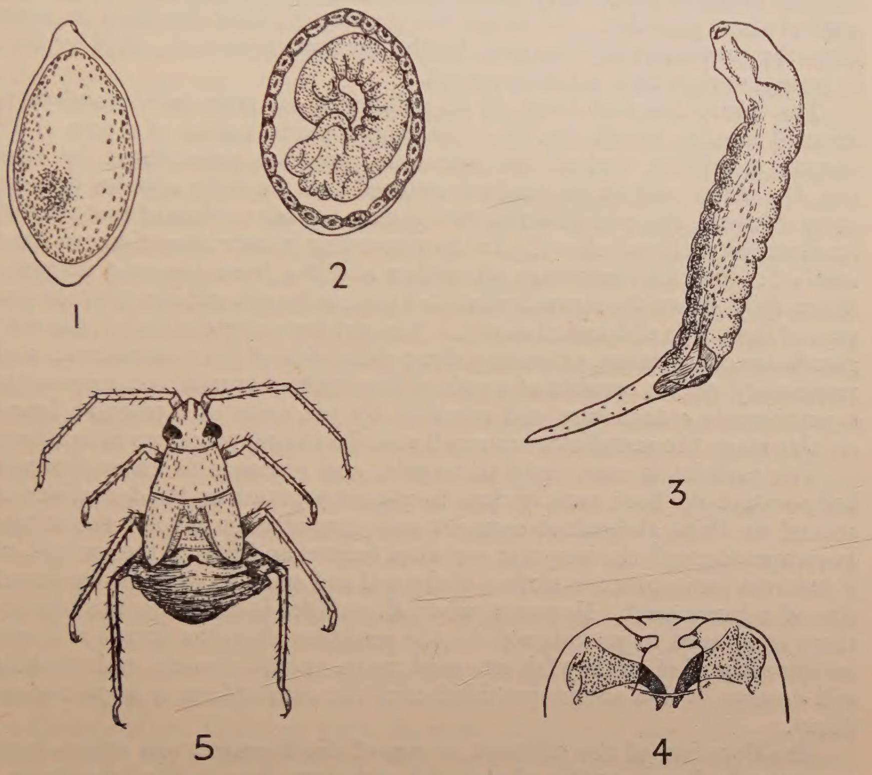
[1] I should like to take this opportunity of thanking both Dr. Ferrière, for his kind assistance in the identification of the parasites reared in the course of this investigation, and Mr. W. E. China, who has once again put me in his debt by help in the review of the literature on the subject.



Figs. 1–5.—1. Egg, an hour after oviposition. × 88. 2. Embryo eight days old within the trophic membrane (seen in optical section). × 25. 3. Larva shortly after hatching. × 25. 4. Mouth-parts of first instar larva. × 88. 5. Nymph of *Calocoris* showing rent in the abdominal wall made by the emerging parasite. × 7.

The egg (fig. 1), which floats freely in the haemocoele of the host, is lemon-shaped, with faint striations down the long axis. Within thirty-six hours a peripheral layer of cells is distinguishable immediately beneath the chorion. Eight days after oviposition the egg has grown to a sphere six or seven times its original diameter, the chorion has become tenuous to invisibility, and the outline of the developing embryo can be discerned through the peripheral layer of cells which forms the so-called "trophic membrane." This structure, which has been described in several species of Braconidae (Haviland, 1922; Jackson, 1928) and in some other Hymenoptera Parasitica also, consists of an envelope of large flattened pentagonal cells with well-defined nuclei which completely surrounds the embryo (fig. 2). When the chorion is ruptured at the hatching of the larva, the cells of the trophic membrane become more or less dissociated and float out into the haemocoele of the host, where for a time they maintain an independent existence. Jackson (1928) has given some account of the function and fate of the trophic membrane in another Braconid *Dinocampus rutilus* (Nees), a parasite of weevils. The dissociated cells increase in size and become loaded with droplets of fat derived from the host's tissues. The nucleus degenerates, and the distended cell wall is easily ruptured. At this stage if a parasitised insect is opened under water, the dissociated cells are at once conspicuous as they pour out into the dissecting dish as a stream of pearly white globules. As larval life progresses, they diminish in numbers since they are gradually devoured by the developing parasite, until by the time of pupation they have all disappeared.

The newly hatched larva of *E. pallipes* is an attenuated caudate form, about 1 mm. in length (fig. 3). The mouth-parts consist of a pair of sickle-shaped mandibles, and of two retractile processes surmounted by sensillae (fig. 4). After ecdysis the cauda is reduced and the body appears proportionately stouter: the gut, hitherto transparent, contains coloured matter, but the tracheal system is still closed. In the succeeding instars these changes are more marked: the tail disappears altogether and the form becomes maggot-like. When fully grown the larva is about 3·5 mm. in length and occupies the greater part of the host's abdominal cavity. The gut is greatly distended, the salivary glands are conspicuous, extending along either side of the mesenteron: and the respiratory system consists of a pair of longitudinal trunks, communicating by a prothoracic commissure and supplied by ten pairs of spiracular branches. At this stage the mandibles are small and the buccal processes insignificant.

The parasite is now ready to pupate, and proceeds to gnaw through the body-wall of the host, usually close to the connexivum on the dorsal side of the second or third abdominal segment and immediately behind the wing-pad. It escapes through the irregular rent thus formed and falls to the ground, where it burrows just under the surface of the soil and spins an oval cocoon about the size of a hemp seed. However, when *E. pallipes* is reared in the laboratory, there is no need to provide soil for the pupation since the larvae will spin up indifferently whether they fall into sand, moss, or cotton wool; and the imagines will emerge in due course provided that the atmosphere is kept reasonably damp.

The duration of the different stages of development was ascertained approximately from samples of material of known date in the laboratory, and the results were checked by dissections from collections made in the field at the same time. The length of the instars varied, probably under the influence of such factors as epiparasitism, stadium of the host, etc.; but usually development, from oviposition to pupation, occupied 34–36 days, and this period was divided fairly equally into embryonic development, from oviposition to the rupture of the trophic membrane, and larval development, from hatching until the time for leaving the host. The duration of the stadia in the second period was variable, but observations suggested that each of the four distinguishable instars lasted about four days.

The life-history of *E. pallipes* in this country closely follows that of *Aridelus* [*Helorimorpha*] in Africa, as described by Kirkpatrick (1937), with this difference: that whereas in East Africa the life of a generation is six or eight weeks only, in Britain the cycle is twelve months, of which more than three-quarters is passed in the pupal state.

The host lived for a day or two after losing its parasite. These voided nymphs were recognisable by their yellowish colour and shrunken and decurved abdomens (fig. 5). In no case did a nymph that had been thus parasitised become adult. Survival indeed is impossible, since by the time that *Euphorus* is ready to spin, the host's abdomen is emptied of most of its contents, except the nervous system, and the gut which is grossly displaced.

The number of Euphorine species parasitic on Heteroptera in this country is not known. All the hosts hitherto recorded belong to the family CAPSIDAE; and in addition to the genera *Calocoris* and *Lygus*, I have records from *Oncotylus viridiflavus* (Goeze) and from *Poeciloscytus unifasciatus* (Fabr.), but in the last two cases the parasites were not reared. It is still undetermined how far this group of BRACONIDAE is specific for different bugs. Kirkpatrick found that *Aridelus* [*Helorimorpha*] would breed readily in three congeneric species of PENTATOMIDAE. If other bugs of the same family were offered, the parasite attacked them but no subsequent larvae could be found. Evidently the host must meet certain requirements in size and bionomics. Among CAPSIDAE, nymphs of the division Miraria swarm at certain seasons and yet they seem never to be attacked by Hymenoptera. Possibly their elongate form could not accommodate the developing parasite. Also, young nymphs must be available in the spring when the parasites appear; and this suggests a preference for Heteroptera with an autumn oviposition over those which hibernate and lay their eggs in spring. All the host species recorded here probably belong to the former group. It is true that *Lygus pratensis* (L.) sometimes hibernates as an adult; but according to Butler (1923) it is doubtful whether the hibernating individuals reproduce in the spring, and it is more likely that the numbers are maintained by individuals hatched in the spring from autumn ovipositions.

Epiparasitism,[2] though not observed in the field, was frequent under laboratory conditions when a parasite was confined for some time in a cage with a potential host. In one instance a nymph was found to contain five dead and one living larvae of *Euphorus*: but in such cases only one parasite survives. However, *Euphorus pallipes* is itself subject to attack by another parasite, a species of *Mesochorus* (ICHNEUMONIDAE). Members of this genus are already known to be endoparasites of BRACONIDAE. Hitherto this hyperparasite has appeared occasionally in collections made in the field, but has not occurred in numbers sufficient to determine its life-history. Apparently it places its egg in the haemocoele of *Euphorus* when the latter, still at an early stage, is itself enclosed within the abdomen of the bug; and, later, the small caudate larva has been observed lying curled up within the posterior region of the transparent body of the *Euphorus* larva. Nothing more is known about the method of oviposition or the later developmental stages of this hyperparasite, but Menzel (1927) gives some particulars of *Stictopisthus*, a member of the same subfamily and a hyperparasite of *Euphorus helopeltidis* Ferr. in Java. According to his observations, hyperparasitisation appears to inhibit the pupation of the Braconid host larva in such a way that, although in due course it falls from the bug and spins a cocoon, it is unable to complete its transformation and is ultimately devoured by the Ichneumonid hyperparasite, which then pupates in the said cocoon.

It is doubtful if *Euphorus pallipes* exercises much control over the numbers of its host. Though widely distributed—Dr. Ferrière tells me that it is the most common species of the family in this country—it is exceptional to find more than 20 or 30% of a given bug population parasitised, and usually the proportion is much less. Moreover, there is only one generation in the year, and the period of activity is relatively short, while, as the bugs feed throughout the growth of the parasite, the damage done to the food-plants can be but little curtailed by the presence of the latter in the area.

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[2] This term has been suggested for cases where a single host has been successively infested by several individuals of the same species of parasite (Haviland, 1922).

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BOOK NOTICE.

Catalogus Coleopterorum Japonicorum. Auct. Y. MIWA et M. CHÛJÔ. Pars 6. 4to. Taihoku, Formosa (Noda–Syobo). 1938.

This is the sixth part of a projected catalogue of the Coleoptera of Japan. It contains 30 families, for the most part poorly represented in Japan. Each family is numbered, but the families contained in this part, while not in numerical order, are continuously paged.

It is anticipated that 103 families require to be catalogued.

THE UTILISATION OF FOOD BY THE LARVA OF THE MEALWORM *TENEBRIO MOLITOR* L. (COLEOPB.)

By A. C. Evans, F.R.E.S., and E. R. Goodliffe, F.R.E.S.

(*Rothamsted Experimental Station, Harpenden, Herts.*)

In a previous paper, Evans (1939), the utilisation of food by the phytophagous larva of *Phalera bucephala* (L.) was described. In the present paper results are given on the utilisation of food by the mealworm feeding on bran and so provides an interesting comparison on the utilisation of two contrasted types of food.

Biological Methods.

About 2330 larvae weighing 192·8 gm. were allowed to feed on a weighed quantity of bran for 4 days at 27° C. Excreta was removed daily by sieving and cleaned as follows. It was first shaken in a fine sieve to remove the flour which was present. The small irregularly shaped particles of food which had passed through the original sieve were removed from the round pellets of excreta by rolling on blotting paper. By rolling the mixture from one side of a large piece of blotting paper to the other, it was found that the round pellets of excreta rolled away, leaving the irregularly shaped pieces of food behind. Several treatments in this way effected a satisfactory cleaning. Some of the fresh excreta produced on the first day was used for the determination of the various proteins, the rest was dried at 103–104° C. The excreta produced on the 2nd–4th days was also dried at the same temperature as was the unconsumed food at the end of the experiment. The original % dry weight of the food was known so that the amount of dry matter consumed could be calculated.

Table I.

Utilisation of food on a dry-weight basis.

Weight of food consumed	65·2 gm.
Weight of excreta produced	35·0 gm.
Weight of food utilised	30·2 gm.

$$\text{Coefficient of utilisation} = \frac{\text{Weight of food utilised}}{\text{Weight of food consumed}} = 0{\cdot}463$$

(uncorrected for uric acid)

Coefficient of utilisation $= 0{\cdot}485$

(corrected for uric acid)

No study was made of the utilisation of water, because it was felt that a special technique would be necessary.

Analytical Methods.

Nitrogenous substances.

Non-protein N was extracted by grinding the material with sand in distilled water for half an hour, washing it into a 100-ml. volumetric flask and making up to mark. Extraction was allowed to continue for 2 hours with occasional shaking. The extract was filtered through a large filter paper and an aliquot

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of 40 ml. of the filtrate was treated with 5 ml. of 10% sodium tungstate and 5 ml. of 0·66 N-sulphuric acid to precipitate the small amount of protein present. The precipitate was filtered off and thoroughly washed with dilute tungstic acid. The non-protein N in the filtrate was estimated by the reduced iron method.

K_2SO_4 soluble protein was extracted by grinding 2 gm. of fresh material in a small glass mortar with clean sand and 10 ml. of 5% potassium sulphate. It was found that grinding for ½ hour was sufficient to reduce the food to a very smooth paste. For the excreta ¼ hour grinding was sufficient. The paste was washed into a 100-ml. volumetric flask with 5% potassium sulphate and made to volume. Extraction was allowed to continue for 4 hours with frequent shaking. The extract was then filtered and the protein precipitated from an aliquot of 40–50 ml. of the filtrate with 5 ml. of sodium tungstate and 5 ml. of 0·66 N-sulphuric acid. The precipitated protein was filtered off, washed 3 times with dilute tungstic acid and the N present estimated by the Kjeldahl method. Gliadin was extracted by grinding 2 gm. of fresh material as above in 15 ml. of distilled water and washing the paste into a flask with 42 ml. of 95% alcohol. After 4 hours extraction with frequent shaking the extract was filtered and an aliquot of 40 ml. was pipetted into a beaker, 25 ml. of distilled water was added and the alcohol evaporated off on a boiling water-bath. The alcohol-free extract was transferred to a boiling tube and enough distilled water added to increase the volume to 40 ml. The protein was precipitated, washed, etc., as for the K_2SO_4 soluble protein. The difference between the total protein content and the sum of the K_2SO_4 soluble protein and gliadin is termed rest protein and this approximates to the glutenin content.

The percentages of the several proteins and the non-protein nitrogenous substances were obtained by multiplying the determined nitrogen percentage by the conventional factor of 5·7.

Uric acid was extracted from the excreta with 1% sodium carbonate and estimated according to Hopkins' method, Cole (1928).

Carbohydrates.

Fructose, glucose, sucrose and starch were estimated by the methods mentioned by Evans (1939). Hemicelluloses were estimated on the starch-free residues by boiling them in 1 + 10 HCl for 2½ hours under a reflux condenser, Mangels (1938). Enough material was not available to estimate the hemicelluloses by more satisfactory methods.

Fat.

Total fat was estimated by the acid hydrolysis method, Mangels (1938). The fat extracted in this manner could not be saponified satisfactorily, as during the drying process it hardened into a cake. Fatty acids were therefore estimated separately as follows. The ether extract obtained after acid hydrolysis was evaporated on a water-bath and saponified in alcoholic potash. The unsaponifiable matter was extracted with ethyl ether and petroleum ether (B.P. 40–50° C.). The fatty acids were extracted with ethyl ether and petroleum ether after acidification. An aliquot of the ether solution of fatty acids was used to determine the iodine value by the method of Margosches, Mitchell (1930).

Ash.

Ash was estimated by the A.O.A.C. official method (p. 278, 8).

RESULTS.

The results obtained are expressed on a basis of 1 gm. of dry food, and show the amounts of the various substances present in that weight of food and in the excreta derived from it, Table II.

TABLE II.

Utilisation of food in mg. per gm. of dry food.

Substance	Food	Excreta equivalent	Utilised	%
Fructose	2·4	1·3	1·1	46
Glucose	1·2	0·4	0·8	67
Sucrose	94·2	4·3	89·9	96
Starch	195·3	80·1	115·2	59
Hemicellulose	266·9	172·0	94·9	36
Fatty acids	54·6	9·5	45·1	83
Unsaponifiable matter . . .	18·9	10·3	8·6	46
Ash	64·0	52·9	11·1	17
Crude protein	156·0	72·1	83·9	54
Uric acid	0·0	22·4	—	—

Only a small percentage of the ash is utilised. The value obtained for *T. molitor* seems to be rather lower than that obtained for early 5th instar phytophagous lepidopterous larvae, Hiratsuka (1920), Evans (1939) and (1939a), who found values between 27% and 30%.

Fatty acids are utilised to a greater extent than the unsaponifiable matter. The iodine value of the fatty acids of the food is 236 and that of the fatty acids in the excreta is 84, indicating that the more unsaturated acids were chiefly utilised. Lepidopterous larvae utilise a similar proportion of the total fat present in their food, but no data is available as to the proportion of fatty acids and unsaponifiable matter utilised.

A great deal of the various carbohydrates present are utilised. Their utilisation by *T. molitor* differs considerably from that of the larva of *Phalera bucephala*. The latter utilises only mono- and di-saccharides. This difference is possibly due to the different distribution of the simple sugars and polysaccharides in the two foods. In bran the simple sugars constitute less than one-third of the carbohydrates estimated while in the plant material they constitute about two-thirds.

In previous studies of the utilisation of food by insect larvae, Evans (1939) and (1939a), it has not been possible to determine whether the different proteins present in the food are utilised to the same extent or not. In the present study this has been possible and the results are given in Table III.

TABLE III.

Utilisation of protein in mg. per gm. of dry food.

Protein	Food	Excreta equivalent	Hydrolysed	%
K_2SO_4 soluble	70·0	8·6	61·4	88
Gliadin	21·6	3·9	17·7	82
Rest protein	49·2	22·3	26·9	55
Non-protein nitrogenous substances	15·2	37·3	?	?
Uric acid	0·0	22·4	—	—

The results show that 75% of the total protein consumed is hydrolysed, but not all of it is utilised, since there is an increase in the amount of non-protein nitrogenous substances other than uric acid in the excreta. If this increase is subtracted from the amount hydrolysed the difference will approximate to the amount utilised, *i.e.* 83·9 mg. or 60%. This figure is a maximum since some of the non-protein nitrogenous substances have probably been utilised. 22·4 mg. of uric acid is excreted and this is equivalent to 42·6 mg. of protein. Thus of the 83·9 mg. of protein about 50% is excreted and about 50% retained. Gliadin and K_2SO_4 soluble protein are more utilised than rest protein. Evans (1939) found that 87% of the protein utilised by *P. bucephala* was retained.

Table I shows that 485 mg. are utilised from each gm. of food consumed, about 93% of this quantity has been accounted for as follows.

Nitrogenous substances	84 mg.
Carbohydrates	302 mg.
Crude fat	54 mg.
Ash	11 mg.
	451 mg.

The method used for estimating hemicelluloses is only approximate and so the percentage of the utilised substances which can be accounted for is only a fair approximation.

Patterson (1938) gives figures for the % utilisation of crude protein, crude fat and carbohydrates in bran by ruminants. The figures are higher for crude protein and carbohydrate but lower for crude fat than those obtained in the present study, Table IV.

TABLE IV.

% Utilisation of bran constituents by ruminants and larvae of *T. molitor*.

	Crude Protein	Crude Fat	Carbohydrates
Ruminants . .	79	68	69
T. molitor . .	54	73	60

The nutritive ratios[1] of bran for ruminants and *T. molitor* are very similar, being 4·0 and 4·7 respectively. Evans (1939a) has obtained nutritive ratios varying from 0·32–1·18 for phytophagous lepidopterous larvae. There is evidently a big difference between these latter and *T. molitor*.

The big difference between the nutritive ratio of the food of lepidopterous larvae and that of *T. molitor* might be related with the big differences in the water content of the food. The food and excreta of *T. molitor* have a much higher % dry weight than the larva, *i.e.* 86%, 85% and 40% respectively. Since there is little difference in the % dry weight of the food and excreta, the larva can absorb but little water from its food. Calculations on the data obtained on a wet-weight basis show that about 60 mg. of water are absorbed together with 378 mg. of solids from 1 gm. of food, *i.e.* about 14% of the food utilised. The extra water to maintain the water content of the larva must therefore be derived from metabolic water. That this is so is shown by the fol-

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[1] The nutritive ratio of a food is obtained from the following expression:

$$\frac{\text{Digestible carbohydrate} + \text{digestible fat} \times 2{\cdot}25}{\text{Digestible protein}}$$

lowing considerations. The ratio of the sum of carbohydrate and fatty acid utilised to N retained from the food can be calculated from the data given. The same ratio for the constituents of the larval tissues can be calculated on data given by Evans (1934). The ratios are

for food	50 : 1
for larval tissues	4 : 1

It is evident that a great deal of the fat and/or carbohydrate absorbed from the food must be metabolised in order to reduce the food ratio to the larval tissue ratio. Also the larval tissues contain fatty acids and carbohydrates in the ratio 1 : 0·67, while in the food the ratio is 1 : 6·85. Mellanby (1932) has shown that the larva of *T. molitor* maintains its water content when starving in a dry atmosphere by the oxidation of food reserves, chiefly of fat. Johansson (1920) reports respiratory quotients of 1·1–1·2 for feeding larvae and states that they indicate a conversion of carbohydrate to fat. The fatty acids of *T. molitor* are a mixture of saturated and unsaturated acids. The unsaturated acids are a mixture of acids containing one or two double bonds, highly unsaturated acids not being present in any appreciable amount. The conversion of carbohydrate into a mixture of the above type does not produce much water compared with its complete oxidation.

$$11C_6H_{10}O_5 = \underset{\text{Triolein}}{C_{57}H_{104}O_6} + 3H_2O + 9CO_2 + 14O_2$$

$$C_6H_{10}O_5 + 6O_2 = 6CO_2 + 5H_2O$$

The above facts lead to the conclusion that the feeding larva of *T. molitor* maintains its water content chiefly by means of the oxidation of ingested carbohydrate.

SUMMARY.

The larva of *T. molitor* utilises nearly half of the food which it consumes. Gliadin, glutenin and K_2SO_4 soluble proteins are utilised. About 60% of the total protein consumed is utilised and about half of this retained. Mono-, di- and poly-saccharides are utilised to different extents. Fatty acids are utilised to a greater extent than unsaponifiable matter. Only a small proportion of the ash is used. About 93% of the substances utilised have been accounted for.

The larva does not utilise as much of the bran as do ruminants. The nutritive ratio of bran for *T. molitor* is similar to that for ruminants, but is very different from that determined for various lepidopterous caterpillars fed on leaves.

The water content of the larva is maintained above that of its food since the larva retains metabolic water produced from the oxidation of carbohydrates utilised from the food.

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Book Notice.

Untersuchungen über den Geschlechtsapparat der aquatilen Wanzen. Von O. Larsén. (*Opuscula Entomologica, Lund* (Suppl. 1).) 8vo. Lund (Entomologiska Sällskapet i Lund). pp. 388, 151 figs.

This paper forms the first Supplementary volume to *Opuscula Entomologica* and is a thesis for a Doctorate of the University of Lund.

After a short introductory part, the work considers in detail the following species : *Nepa cinerea, Ranatra linearis, Naucoris cimicoides, Aphelocheirus aestivalis, Notonecta glauca, Corixa dentipes, Sigara sahlbergi.* Under each of these species the structure of the genitalia and the function of the organs are discussed in detail. After dealing with each species specially, is a chapter in which all the species are considered generally. This is followed by a chapter dealing with systematic matters and a section dealing with Biology. A bibliography and contents complete the work. There is no index. Many of the references given in the bibliography leave something to be desired.

In addition to the species dealt with in detail in this work, Dr. Larsén has examined material of other aquatic bugs, and in the general considerations he makes comparisons with other Hemiptera, especially Heteroptera, and in the same part summarises the more important conclusions reached from his special studies.

The views of the author on the systematic results of his studies are given in a special chapter.

Book Notice.

Empire Cotton Growing Corporation. Cotton Pest Control Work in Southern and Central Africa and the Rhodesias. Report on a tour undertaken by Prof. J. W. Munro, March–July, 1937. London. pp. 37. Price 2*s.* 6*d.* 1937.

This pamphlet is the report of Prof. Munro to the Empire Cotton Growing Corporation on his tour in Africa carried out at the request of the Corporation.

Certain recommendations are made for the better execution of the control measures against cotton pests. Some of the recommendations have been acted on and others accepted in principle.

A NOTE ON THE FUNCTION, INCIDENCE AND PHYLOGENETIC IMPORTANCE OF THE BASAL ACCESSORY ANTENODAL NERVURES IN THE ORDER ODONATA

By Lt.-Col. F. C. Fraser, I.M.S. Retd., F.R.E.S.

Antenodal nervures occur in the Odonata as a double series of short transverse veins running between the costa and subcosta (*costal antenodals*) and between the latter and the radius (*subcostal antenodals*). The costal antenodals may or may not be in strict alignment with the subcostals, but there is a strong tendency in the order towards the latter arrangement and it has already been perfected in the families Agriidae, Epallagidae and Libellulidae.

The antenodal nervures may be classified as primaries, secondaries and accessories as follows :—

Primaries. In the more archaic types of Odonate wings, such as those of the Protozygoptera and Coenagrioidea, only two antenodals are found. These are the primaries or primitive pair, and they have been preserved in all recent dragonflies save the Agriidae, Epallagidae and Libellulidae. They are readily distinguished from the other antenodals by their more robust build and by the bridging of the angle formed between their two halves by membrane.

Secondaries. Dating from the first appearance of the Amphipterygidae, probably in the Triassic, additional antenodals made their appearance in the costal and subcostal spaces, at first few and irregularly spaced, but later more numerous and tending towards alignment of the two series. These were the *secondaries*, and their function was to reinforce and ultimately replace the primaries.

Accessories. Finally, in comparatively recent times, but dating as far back as the Jurassic in some of the Zygoptera, additional antenodals made their appearance in the space between the base of the wing and the proximal primary antenodal, which, hitherto, had always stood as the most basal of all the antenodals. These are the accessory basal antenodals or *accessories* which form the subject of the present paper.

Many students of the Odonata have been intrigued as to the exact function of these nervures, but apart from taxonomic value, none, I believe, has thought to place any phylogenetic importance on their presence in the wing. They have been employed as specific and generic characters by several authors. The late Herbert Campion examined many hundreds of Libelluline wings in a vain attempt to find basal accessories present; it is probable that he considered them of importance in the phylogeny of the family but he never committed himself by expressing any opinion on the subject (Campion, 1913, *Proc. Acad. nat. Sci. Philad.* **1913** : 220).

An examination of the wings made throughout the Odonata shows the following incidence of accessory antenodals :—

Aeshnidae : *Caliaeschna*, *Cephalaeschna*, *Gynacanthaeschna*, *Periaeschna*, *Petaliaeschna*, *Indophlebia*, *Amphiaeschna*, *Indaeschna*, *Boyeria*, *Telephlebia* (fig. 6), *Heliaeschna*, and two species of *Gynacantha* (*membranalis* Burm. and *gracilis* Selys).

GOMPHIDAE: *Cyclogomphus*, *Merogomphus*, *Macrogomphus*, *Leptogomphus*, *Podogomphus*, *Notogomphus*, *Progomphus*, *Sieboldius* (100%), *Hagenius* (33%), *Anisogomphus bivittatus* Selys and *A. orites* Laidlaw, *Gomphus personatus* Selys, *G. nilgiricus* Laidlaw, *G. melaenops* Selys and *G. graslini* Rambur, and *Davidius fujiama* Fraser.

CORDULEGASTERIDAE: *Chlorogomphus*, in group *magnificus* only.

CORDULIIDAE: entirely absent in *Synthemiopsis*, present and apparent in most species of *Synthemis*, present but not apparent in all other genera due to perfected homogeneity of the antenodal complex.

LIBELLULIDAE: present but not apparent in all genera from the same cause as given for the last family.

COENAGRIOIDEA: absent throughout this superfamily, species belonging to which possess only the primitive pair of antenodals.

AMPHIPTERYGIDAE: present only in *Devadatta* and *Philoganga*.

CHLOROCYPHIDAE: entirely absent throughout this family.

HELIOCHARITIDAE: present in *Cyanocharis*, *Charitocharis*, *Dicterias* (fig. 3) and *Heliocharis*.

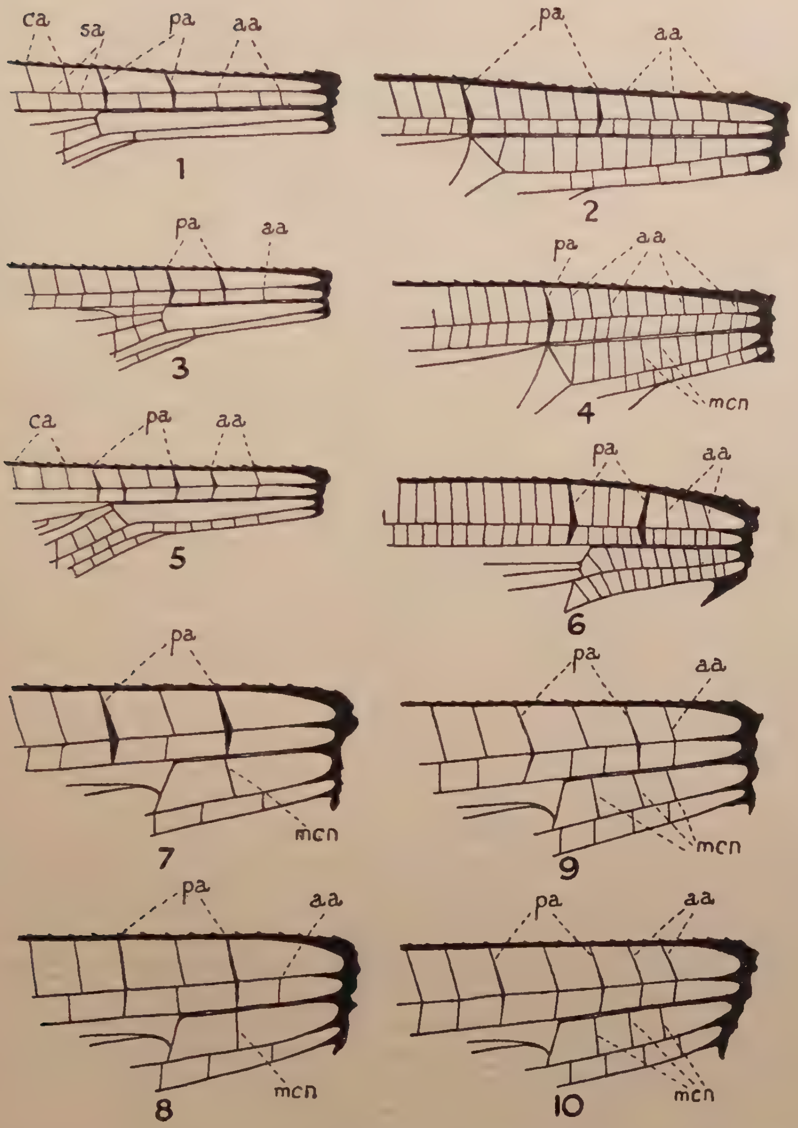
POLYTHORIDAE: *Polythore* (fig. 4), *Euthore*, *Cora* (fig. 2), *Chalcopteryx* and *Miocora*.

EPALLAGIDAE and AGRIIDAE (*Hetaerina* and *Mnesarete* are included with some doubt in the latter family): present but not apparent in all genera due to the same cause as given for the CORDULIIDAE and LIBELLULIDAE.

In the above list, it will be noted that the three families EPALLAGIDAE, AGRIIDAE and LIBELLULIDAE have the accessories present although not apparent, a fact which I have attributed to the antenodal complex assuming a homogeneous character. Now it is in these three alone that the primary antenodals have entirely disappeared. In the case of the CORDULIIDAE the accessory antenodals are also present, though generally not apparent, but here the primaries are only partially atrophied. In *Synthemis*, the most primitive genus of this family, the accessories are in process of being added and I find that the primaries have lost but little of their primitive robustness. Finally in *Synthemiopsis*, where accessories have not yet begun to be added, the primary antenodals have retained their primitive condition unchanged. Clearly, then, there is some relationship between these two states: that is, between the presence of accessories and the atrophy and disappearance of the primaries.

In all families other than the three in which the primaries have become obsolete, the space between the axilla of the wing and the proximal primary antenodal is normally empty of antenodal veins. The filling up of this space with accessory veins appears to be essential before atrophy of the primaries can take place. Actually one is able to see this process taking place, step by step, in the primitive members of the CORDULIIDAE, where an almost unbroken chain of evolution is depicted.

In *Synthemiopsis*, the most archaic genus of the CORDULIIDAE, the primaries are still in their original primitive state of development and the secondaries lack alignment; there is a complete lack of homogeneity in the antenodal complex and, as yet, no evidence of that evolution taking place which is to convert it into the homogeneous and Libelluline character which prevails in the higher members of the family. In the adjacent genus *Synthemis* an extremely variable antenodal complex is met with, ranging from forms nearly as primitive as *Synthemiopsis*, to others almost as highly organised as the LIBELLULIDAE.



Figs. 1–10.—Base of wing of: 1. *Philoganga loringae* Fraser, 2. *Cora terminalis* McLachlan, 3. *Dicterias sanguinea* Selys, 4. *Polythore beata* McLachlan, 5. *Devadatta multinervosa* Fraser, 6. *Telephlebia godeffroyi* Selys, 7. *Synthemis leachii* Selys (note absence of accessory antenodals), 8. *Synthemis gracilenta* Lieftinck and *Synthemis primigenia* Förster (note the presence of a single accessory antenodal), 9. *Synthemis eustalacta* (Burmeister) (note that the incomplete accessory antenodal has now become complete), 10. *Synthemis flavoterminata* Tillyard (note that two complete accessory antenodals are now present and the primary antenodals have almost atrophied). Notation: *ca*, costal antenodals, *sa*, subcostal antenodals, *pa*, primary antenodals, *aa*, accessory antenodals, *mcn*, median cross-nervures.

In *S. leachii* Selys (fig. 7), the secondaries are not yet aligned, accessory antenodals are absent and the primaries are nearly as conspicuous as they are in *Synthemiopsis*. (Possibly occasional specimens may exhibit these accessories, but, so far, I have failed to find such examples, and, to judge by the primitive state of the antenodal complex, would not expect to find them.)

In *S. gracilenta* Lieft. and *S. primigenia* Förster (fig. 8), and I think in all four of the New Guinea species, the secondaries are not aligned in the fore-wings but are strictly so in the hind-wings. This is of great interest as it is a well-recognised fact that the evolution of the hind-wing, in Odonata, is always a stage ahead of that of the fore-wing. Thus two steps in the evolution of the antenodal complex are exhibited in the same insect. The primaries are still quite evident, although exhibiting signs of atrophy; a single subcostal accessory is present in all wings (rarely absent in one or more wings).

The next step is found in occasional specimens of *S. eustalacta* (Burm.) (fig. 9), where the subcostal accessory antenodal has now become complete by extending into the costal space. The primaries here show distinct signs of atrophy.

Finally in *S. flavoterminata* Tillyard (fig. 10), a species which appears to be far in advance of all others in the genus, the secondaries are in alignment in both fore- and hind-wings, the primaries are atrophied to such a degree, that they are hardly noticeable and *there are now two complete accessories present. If complete atrophy of the primaries had occurred, it would be impossible to have recognised the presence of these two complete accessory antenodals.* In this species, therefore, one finds the antenodal complex assuming a Libelluline character, and it serves to interpret the actual condition prevailing at the base of the Libelluline wing. In the AGRIIDAE, EPALLAGIDAE and LIBELLULIDAE, owing to the complete atrophy of the primaries, the individuality of the accessory antenodals has become obscured. One must therefore assume that all of these three families were once characterised by the possession of a pair of primitive antenodals such as is found in the rest of the Odonata.

Arising out of this investigation, a very interesting association of median cross-nervures with accessory antenodals has been found to exist and, from this, it seems probable that the median cross-nervures play some important part in the evolutionary process described above. Thus in those genera of AESHNIDAE which possess median cross-nervures, accessory antenodals are invariably found; the one kind is never found without the other; I have been unable to find a single exception to this rule. In those few genera of the CORDULIIDAE where median cross-nervures exist, accessory antenodals are absent. In the GOMPHIDAE, an exactly opposite condition is found, for in those genera and species where accessory antenodals are found, median cross-nervures are absent (only a single specimen in the whole of the family GOMPHIDAE has been found to possess median cross-nervures, viz., a female of *Karschiogomphus ghesquierei* Schout.).

In the CORDULEGASTERIDAE a still more intriguing condition exists: in the genera *Allogaster*, *Anotogaster* and *Cordulegaster* neither median cross-nervures nor accessory antenodals are found; in group *atkinsoni* of *Chlorogomphus* median cross-nervures first appear, and in the second group *magnificus*, both median cross-nervures and accessories are present.

In the Zygoptera, the two types of nervures are found constantly associated in the POLYTHORIDAE and in *Heliocharis* of the HELIOCHARITIDAE.

One may now sum up the theory in the following axioms: those species, genera or families in which one or more complete accessory antenodals occur are more recent than those in which only incomplete or subcostal antenodals occur.

Secondly those in which accessory antenodals of any kind occur are more recent than those in which they are absent.

Lastly, families in which the primary antenodals are absent, come under the first category, viz., those in which the accessories are multiple and complete, and represent the highest expression of evolution so far attained in the Order Odonata.

The family CORDULEGASTERIDAE well illustrates the first two of these axioms: of the four genera comprising this family, *Chlorogomphus* alone possesses both median cross-nervures and accessory antenodals and should therefore be the most recent. This is confirmed by the wide differentiation existing between the sexes and the specialisation found in most females. Of the two groups composing the genus, *magnificus*, alone, possesses accessory antenodals as well as median cross-nervures; it should therefore be more recent than group *atkinsoni*. Here again one finds confirmation in the much higher differentiation reached between the sexes; so high in fact that the two sexes of the genotype were originally described as two separate species. Finally in group *magnificus* all save *C. mortoni* Fraser have the accessory antenodals incomplete and in the subcostal space only. In *C. mortoni* the accessories are not only complete but two in number, so that it should be the most recent species of the genus. This is again confirmed by the high state of specialisation attained in its anal appendages and shape of abdomen. By employing the accessories in this instance, I have been able to determine correctly the highest genus in the family CORDULEGASTERIDAE, the highest group in the genus *Chlorogomphus* and, lastly, the highest species in that group.

A parallel instance is afforded by the genus *Synthemiopsis*, and by the species *S. flavoterminata* Tillyard in the family CORDULIIDAE; this has been already sufficiently explained above.

In the list of genera given above, *Sieboldius* is shown as possessing accessories in 100% of its wings, whilst *Hagenius*, a genus regarded by some authors as doubtfully distinct from *Sieboldius*, shows a percentage of only 33%. Williamson has employed the accessories as a character to separate the two genera, but gives *Hagenius* incorrectly as negative for these nervures (Williamson, 1907, *Proc. U.S. Nat. Mus.* **33** : 272). The higher percentage of accessories in *Sieboldius* places it ahead of *Hagenius*, which, as it is the dominant genus, is probably correct.

The entire absence of accessories in the family CHLOROCYPHIDAE is instructive, as their classification has always presented great difficulties. From the negative evidence of these nervures I regard the family as very archaic and am of opinion that they arose from the very root of the AMPHIPTERYGIDAE, probably in the Triassic. The primary antenodals, in them, are still quite primitive and no accessories have been added proximal to the proximal primary.

In the Zygoptera, the EPALLAGIDAE and AGRIIDAE have reached the highest state of development, whilst in the Anisoptera, the LIBELLULIDAE have attained a similar position. If I am correct in my theory in regard to the latter, then there is added a melancholy interest to the search made by my old colleague Mr. Campion, for although he was unable to detect any accessory antenodals, they were actually present in every wing he examined!

In working out theories such as the present one, anomalies, exceptions to the rule, are bound to arise. One such presents itself in the Aeshnine genus *Telephlebia* (fig. 6), where, with a number of accessory antenodals, usually three complete ones in all wings, there are no signs of atrophy of the primary antenodals such as I would be led to expect alongside such a condition. This is, however, the only exception that I have been able to find, and I regard the presence of accessory antenodals here as part of a general redundancy of cross-veins in the wings of this genus; venation, in fact, appears to have run riot, since, in some places, the antenodals have formed a network paralleled only in the fossil genus *Aeschnidium*.

SUMMARY.

This paper deals with the accessory basal antenodals (*basal subcostal nervures* of some authors) and is complementary to a previous paper dealing with the primary antenodals which appeared in these Proceedings (1937, *Proc. R. ent. Soc. Lond.* (A) **12** : 101–107).

The accessory antenodals are shown to be a part of and a continuation of that process by which secondaries are added to replace the primitive primaries. Examples showing the successive stages in the evolution of this process are given which serve to demonstrate the importance of the accessory antenodals in the taxonomy and phylogeny of the Order Odonata. In the higher families EPALLAGIDAE, AGRIIDAE and LIBELLULIDAE, owing to complete atrophy of the primary antenodals and alignment of the secondaries, the accessories, although present, are not apparent, the antenodal complex now having attained complete homogeneity.

BOOK NOTICE.

Festschrift zum 60. Geburtstage von Professor Dr. Embrik Strand. Vol. 5 (Schluss-Band !). pp. 750, 10 pls., front., 74 figs. 8vo. Riga, 1939.

This, the twice-promised last volume, completes the " Festschrift " to Prof. Strand. Few Zoologists will receive such a collection of writings on their sixtieth birthday.

The volume contains 28 papers of which 8 are of interest entomologically. A long supplement to Sherborn's *Index Animalium* is printed in this volume.

The work is completed by a separately issued title-page and contents to the five volumes. The index is published in vol. 5.

BOOK NOTICE.

Catalogus Lepidopterorum regionis palaearcticae. Editus ab O. BANG-HAAS. Lieferung 9.

This 9th part of the new " Staudinger and Bang-Haas " Catalogue continues the work of which details are given in this Journal **13** : 86.

It comprises pages 129–144 from the genus *Coenobia* to *Naarda* and completes the NOCTUIDAE. The index to this family will appear in the next part. Mons. C. Boursin has read the NOCTUIDAE of the Catalogue.

RECORDS OF BUTTERFLY MIGRATION IN AFRICA (LEPIDOPT.)

By C. B. Williams, Sc.D., F.R.E.S.
(*Rothamsted Experimental Station.*)

In continuation of my previous policy I now put on record a further series of accounts of migrations of butterflies. These have been sent in to me during the past two or three years by various correspondents, and I should like to take this opportunity of expressing to them my thanks for their co-operation.

The following flights are discussed below :—

	Nos.
Catopsilia florella (Fabr.) .	1–7
C. florella and others . .	8
Belenois (*Glycestha*) spp. and *C. florella* . . .	9–11
Belenois mesentina Cram. (*G. aurota*) . . .	12–14
Vanessa cardui (L.) . .	15–16
Libythea labdaca Ww. .	17–18
Syntaruchus telicanus Lang	19
Atella phalantha (Drury) .	20

(1) *C. florella* in S. Rhodesia in 1935.

Mr. — Peat has kindly sent me the following record from Gatooma, S. Rhodesia, in December 1935 :—

" During the last few days I have noticed a movement of butterflies. The butterflies have all been white as the one enclosed. I have noticed them for the last four days, 26th–29th, December 1935, all flying towards the quadrant East, South-East, South. They appear to be flying through the day, singly or in pairs, so that standing, say in the middle of a field, within the range of vision one could always see two, three or a few, but never any considerable number.

" They have been flying against an E. to S.E. wind of from 1 to 3 force. The weather bright and fine. The last rain was on the 21st Dec. The majority were flying low to the ground."

One specimen sent was *C. florella*.

(2–3) *C. florella* in S. Rhodesia in November and December 1936.

Mr. Wm. Houston kindly sent me the two following records :—

(2) On 13 November 1936, between Gatooma and Umsweswe, S. Rhodesia, he saw a movement of *Catopsilia florella*. They were flying strongly in a westerly direction with only just sufficient height to clear natural obstacles. They were widely spaced, but with no blank intervals. First seen at 10 a.m. and continued throughout the day, with a few stragglers on the following day. The rainy season had just commenced. The weather was moist with alternate sunshine and shower. Wind fitful, very slight, and in no set direction. All seen were of the one species, and Mr. Houston sent me one specimen by which I was able to confirm the identification.

(3) On 22 December 1936 at Umsweswe, *Catopsilia florella* passing in a S.E. direction, flying low into a slight breeze. Weather hot and damp but no

rain. The butterflies passed on spasmodically throughout the day, the numbers to be reckoned in hundreds.

On the 23rd with similar conditions they passed in increased numbers. On 24 December numbers just as great, but speed greater as the wind was now behind them. On 25 December as thick as ever. On 26th and 27th still in large numbers; decreased from then to 31 December, but still passing, sometimes in dozens up to 6 January.

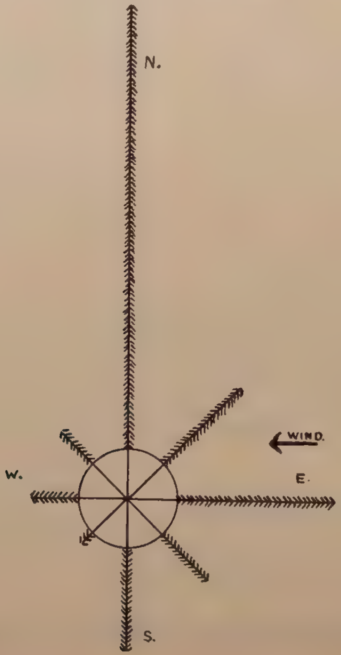
They definitely tailed away on 7 and 8 January 1937.

Weather throughout hot and moist with little or no rain. Flight always to S.E.

(4–6) *C. florella* in N. Rhodesia in 1936.

Mr. J. M. Winterbottom kindly sent me the three following records of migration of *Catopsilia florella* in Northern Rhodesia :—

(4) 3 and 4 November 1936, many thousand examples all moving due East at Lundari and also seen 8 miles east of Lundari.



(5) 29 November 1936, the same species flying towards the *West* at Fort Jameson.

(6) 26 December 1936, the same species again flying towards the West at Fort Jameson, weather hot, stuffy, alternately sunshine and cloud.

Mr. Winterbottom sent a specimen from the first migration which enabled me to confirm the identification. He adds that the wind was usually from the east and the height of flight was from ground-level up to at most 20 feet.

(7) *Catopsilia florella* in Natal in 1937.

Mr. J. T. Marshall kindly sent me the following record :—

At Barberton, Natal, the early part of February 1937 was very wet with 13 inches of rain in the first two weeks. The weather then became fine.

About 7 February a few butterflies were noted migrating and they became gradually more abundant until on the 18th there was a very definite flight. At 10 a.m. on the 18th Mr. Marshall took a count of flight direction for 15 minutes with the following result :—

Flying to	N.	NE.	E.	S.E.	S.	S.W.	W.	N.W.
	93	23	33	14	22	3	10	9

This shows a very distinct movement towards the N. and to the E. of north (see fig.).

The wind was a gentle breeze from the east. Mr. Marshall sent me 78 specimens, of which 76 were *C. florella* (including only 3 of the yellow form), one *Terias brigitta* (Cram.) male, and one *Precis hierta* male. The flight may therefore be considered to be definitely of *C. florella.*

(8) Migration of Butterflies in S. Rhodesia in 1934.

Mr. Wm. Houston informs me that he saw a large migration of butterflies in the Gatooma district of Southern Rhodesia from 7 to 9 March 1934.

They were first observed on 7 March flying overhead due east. " They were flying strongly and at height, making no deviation from their course and the numbers could only be likened to a swarm of locusts." Mr. Houston observed them at two points a mile across the front, and he heard reports that they had been seen at places 5 and 20 miles distant in similar numbers. They continued to pass for 3 days; at times the numbers would diminish, but fresh waves followed on. The evening of the third day brought a real tropical rainstorm and next morning the butterfly world was back at normal.

Mr. Houston states that they were chiefly whites and yellows, with *Catopsilia florella* predominating, and large numbers of Danaines, Acraeines, *Hamanumida daedalus* (Fabr.), *Atella phalantha* and *Lachnoptera ayresi* Trim. were mixed with them.

He adds that this was the first extensive movement that he had seen during 10 years' residence in S. Rhodesia.

(9–10) White and Yellow Butterflies in Kenya in 1932 and 1933.

Miss C. Harvey allows me to record two flights observed by her as follows :—

(*a*) On 28 April 1932 at a farm on Kinankop, above Lake Naivasha, and about 8000 feet above sea-level, a swarm of large white butterflies, accompanied by a few of pale yellow colour, flew for several days up the valley and along the edge of the escarpment in a southerly direction.

A newspaper cutting at the time announced that the flight was still continuing past Nakuru and Cherangani.

(*b*) In 1933, at Njoro near Nakuru, from 18 to 25 March a migratory swarm of white butterflies passed in a northerly direction. There was no prevailing wind at the time but frequent small whirlwinds or dust-storms would occur, and at these times the butterflies all settled in the grass until they were over. On a line of about 200 yards in length she counted 100 passing in 2 minutes and the procession continued all day.

I sent specimens of the principal East African migrants to Miss Harvey, and she said that—from memory—she thought the first flight was *Catopsilia florella* and the second a species of *Glycestha* (*Belenois*).

(11) *Belenois* spp. and *Catopsilia florella* in Kenya in August 1937.

Sir Edward Poulton kindly allows me to record the following notes from a letter written to him by Canon K. St. A. Rogers on 28 September 1937, from Ngong, Nairobi, Kenya :—

" During most of August [1937] *Belenois severina* and *B. mesentina*, (*Glycestha creona* and *G. aurota*) together with smaller numbers of *Catopsilia florella* were moving steadily from west to east. At no time were great numbers on the move, but I was able to satisfy myself as to the certainty of the movement. It was not easy to make sure as August, as usual, was a cloudy month and bright sunshine was scarce. Moreover, the species concerned had been present in abundance for some months and are still plentiful.

" The distribution of rainfall at this time of the year is peculiar. We are in our long dry season and, with the exception of one thunderstorm in July, have had no rain to speak of for three months. Going east the climate gets dryer still and for about 200 miles, beginning about 50 miles east of Nairobi, June to September inclusive, are frequently absolutely rainless.

" In the west, about 50 miles away, there is generally a fair amount of rain during the whole time and on the western slopes of the main hills the rainfall is generally heavy, which was the case this year. In fact to the west of the Rift Valley it is one of the wettest periods of the year.

" This year, though we have had our usual dry season, we are not so desiccated as usual and there is still plenty of green grass; no doubt the result of exceptionally heavy rain in May.

" So the migration was out of a district where rainfall was abundant into one of drought.

" I should have said that the wind was light and variable, mainly east."

(12) *Belenois mesentina* (*Glycestha aurota*) in Gulf of Aden.

Lt.-Col. H. F. Stoneham records that on 15–16 June 1933 when he was on board a steamer off Cape Gardefui and in the Gulf of Aden, the boat passed through migrating white butterflies, *Belenois mesentina* (*Glycestha aurota*) all moving from the African coast northwards towards Arabia.

(13) *Belenois mesentina* (*Glycestha aurota*) in Sudan.

Mr. J. W. Cowland records that on 5 March 1936 he saw a large swarm of *Belenois mesentina* (*Glycestha aurota*) between Kurma (lat. 13.37, long. 21.18) and Om (lat. 13.38, long. 24.35) on the Fasher–Kebkebia road, all drifting slowly towards the west.

(14) White butterflies in Pretoria.

Dr. E. G. Smith informs me that he lived in an eastern suburb of Pretoria, S. Africa, from 1922–29 and that in the early summer (*i.e.* October or November) of each of the years 1927, 1928 and 1929 he witnessed a migration of butterflies, with the following characteristics :—

(1) The butterflies always flew from south to north.

(2) The flights were not dense, say, one butterfly every 10 yards in four or five tiers.

(3) The species appeared to the " large white."

(4) On no occasion did they settle or appear fatigued. The flight was strong and hurried, and they allowed no obstacle to deflect them from their direction of due north, flying over the tops of the highest trees.

(5) The flight took from one to two hours to pass.

In view of other records from this district, it seems likely that the species concerned was *Belenois mesentina* (*Glycestha aurota*), but it is not possible to be sure until many more records with specimens are available.

(15) *Vanessa cardui* at Homs, Libya, in April 1937.

Mr. L. M. Parlett allows me to record that on 17 and 18 April 1937 he saw a large migratory flight of *V. cardui* coming inland from the sea, *i.e.* from north to south at Homs, Libya. The direction of the wind was N.W.

The butterflies appeared to be weary after a long flight across the sea. They flew near the ground, only clearing the bushes and small thorn trees; few, if any, as high as the telegraph wires.

The swarm had become considerably scattered. Although the majority were still on the wing, all heading southwards, large numbers settled on the bushes, on the ground, and even on the bare road.

On the morning of 17 April he followed the new littoral road eastward across the line of flight for over a mile without coming to the limit of the swarm. The flight was still continuing on the morning of the 18th, though in diminished numbers.

The insects must have been numbered by hundreds of thousands, possibly by millions.

(16) *Vanessa cardui* in Sudan.

Mr. W. L. P. Cameron noted that in October 1935 *Vanessa cardui* was observed flying about in large numbers throughout the Dongole District, Sudan, and further north.

(17–18) *Libythea labdaca* in the Gold Coast.

(17) Mr. Bundy informs me that, in October or November 1932, he saw between Tafo and Kumasi, Gold Coast, large numbers of a small brown butterfly moving steadily in one direction, settling at times. He does not recollect the direction.

(18) Mr. A. Foggie reports on a flight of *L. labdaca* at Dunkwa, Western Province, Gold Coast, as follows :—

On 13 October 1938 a steady flight was first noticed at 1.15 p.m. across the bungalow compound. The butterflies were all the one species and flying very fast. About 1.30 the numbers dropped for a few moments and then increased again until they were as thick as before. The flight was still continuing at 2 p.m., when he walked through it for about a quarter of a mile. Some were flying just above the ground, and a few above the tops of the tallest trees about 100 feet above the ground, but the greatest numbers were between 4 and 12 feet up. The last stragglers passed his office about 2.15.

The day was hot (84° to 86° F. in the shade), fine and windless. There had been rain the previous day. The direction of the flight was due north, and the butterflies flew steadily on their course, only deviating to avoid obstacles.

About 2 p.m. Mr. Foggie noticed that large numbers of the butterflies came down and settled on the surface of a black "tarmac" road. They only remained for a second and then flew on. This did not occur on the red laterite road, and he thinks that the black road was mistaken for a wet surface.

On the following day at the same time, 1.15 p.m., a very small bunch of the same butterflies flew in the same direction, but they were only noticed for a few minutes.

Mr. Foggie also notes that he had heard reports of similar flights of brown butterflies at Oda in the Central Province and also in the Eastern Province, but he himself had observed no other similar flight in the Western Province during his residence there since 1936. Mr. Foggie sent three specimens, two of which were *L. labdaca* and the third *Precis sophia* Fabr. The latter is not known as a migrant and was probably captured in error.

Dunkwa is about 100 miles inland from Sekondi on the Sekondi–Kumasi Railway.

Libythea labdaca has been previously recorded as migrating in Nigeria, Gold Coast and Sierra Leone.

All but one of the records for Nigeria, the only record for Sierra Leone and two records for the Gold Coast were for the months of March, April and May, but there were two previous records for the Gold Coast of flights in August and September. The two records above by Mr. Bundy and Mr. Foggie confirm the existence of the second flight season in the Gold Coast, but there is not yet enough evidence available to discuss flight directions.

It is interesting to note that Farquharson in 1918 stated that there was a second flighting season in Nigeria, but there is so far only one exact observation in support of this.

(19) *Syntaruchus telecanus* in the Gulf of Suez.

Mr. Donald Sturdy wrote that on 14 June 1936, when he was on board s.s. *Mantola* at about 5 p.m., and about 1½ hours after leaving Suez on the way south, a considerable flight of blue butterflies was seen passing from approximately S.W. to N.E. lasting for about 20–30 minutes or longer, with an average density of one butterfly per 50 ft. cube. The wind was approximately S.S.W.

The same evening about 11 p.m. a number of small blue butterflies were noted, in the Café lounge of the steamer, which are believed to be identical with those of the flight earlier in the evening. Six specimens were captured by Mr. Sturdy and sent to me. They have been identified at the British Museum as *Syntaruchus telecanus aegyptiacus*.

(20) ?*Atella phalantha* off E. African Coast.

Lt.-Col. H. F. Stoneham informs me that on 12–14 June 1933 when he was off the East African Coast on a voyage from Mombasa towards Egypt, the boat passed through migrating butterflies flying to the north-east. No specimens came on board but the species appeared to be *Atella phalantha*, a previously known migrant. No land was in sight.

A MIGRATION OF BUTTERFLIES IN COCHIN CHINA (LEPIDOPT.)

By Katherine J. Fisher, F.R.E.S.

The flight described below was observed on 16 April 1938 on the road between Saigon, Cochin China, and Djïring, Annan. It is of special interest as being the first record of a migration in this part of the world, and also because the flight included several species of butterflies not previously recorded as migrants.

About 9.0 a.m. during a short stop in a motor drive I noticed a number of butterflies about, with a faint suggestion of a directional flight. All down the road, as we drove on, the number of butterflies increased until, when about 10 miles or so on the Cochin China side of the Annan border, it became obvious that a migration was in progress. The flight was chiefly composed of a species of *Papilio* [*aristeus*, see below], a pretty insect about the size of our English Swallow-Tail, but dark in colour with longitudinal blue stripes. A good many other species were also concerned, about 10 % of the flight being a white butterfly (*Appias* spp.) and a further 1 % of the greatest diversity of species—Danaines, *Papilio* spp., *Euploea* spp., etc. The main direction of the flight appeared to be to S.W. or S.S.W. The direction at this stop was taken with a compass. The butterflies seemed to be using the road for the convenience of its clearing through the jungle, and tended to follow its windings to a certain extent. When the road direction was quite incorrect, they seemed to filter through the jungle until they found the road again at the other side of the bend. No butterflies were noticed to fly above the level of the trees; they seemed to filter through them. Over the road they flew at a height of 1–15 feet above the ground. The speed of flight of the chief *Papilio* species was about 6–8 m.p.h.; the other species a bit faster, especially the *Euploea* species and some large dark *Papilio* which could not be caught. The butterflies seemed to skirt the shadow of a big tree under which the car had been stopped, as if they preferred the sunlight. The wind was very light and the direction could not be determined.

I tried to count the number of butterflies passing on a 12-foot front. About 30 passed in the first half minute, then came a bunch of one hundred or more.

We drove on for about 10 kilometres and the numbers had increased to snowstorm proportions.

Large groups were settling on some turned earth. This was not by any means wet or even damp, although in this moist climate it was not as dry and dusty as it would have been even an hour or two after being turned on a hot day in England. I first thought that it might be an ants' nest, but no ants appeared when it was stirred. My companions thought that the earth might have been turned during the night by wild boar or something of that kind. The butterflies did not appear to be feeding, but unfortunately very little time could be spared for watching.

We continued through the flight for another 10 kilometres or so, crossing the Annan border, but as we approached the Annan mountains the flight thinned out; and when the mountains were reached, about 11.0 a.m., no more were seen.

It was the end of the dry season and the weather had been very hot and dry for the previous three days.

PROC. R. ENT. SOC. LOND. (A) 14. PTS. 4–6. (JUNE 1939.)

About 50 specimens captured during the flight were kindly identified by Mr. N. D. Riley and Mr. G. Talbot at the British Museum (Natural History) as follows :—

PAPILIONIDAE.

36 *Papilio aristeus hermocrates* Felder, mostly males.
2 *Papilio hipponous pitmani* Elwes and de Nic., males.
2 *Papilio macareus indochinensis* Fruh.
* 2 *Papilio doson axion* Felder.
2 *Eurypylus cheronus* (Fruh.).

PIERIDAE.

* 3 *Appias leis pseudoleis* Fruh. (= *paulina pseudoleis*), males.
* 3 *Appias albina darada* (Feld.), males.
* 1 *Cepora (Huphina) nerissa dapha* (Moore) (wet form), male.
* 1 *Catopsilia crocale* Cram. race, small specimen, male.
1 *Leptosia nina* (Fab.) (= *xiphia*), male.
1 *Eurema* sp ?, male.

DANAIDAE.

* 1 *Danaus septentrionis* Butler, female.

LIBYTHEINAE.

1 *Libythea narina* Godt. race, male.

The species marked with an asterisk have been previously recorded as taking part in migratory flights.

BOOK NOTICE.

Horticultural Colour Chart. Issued by the British Colour Council in collaboration with the Royal Horticultural Society. 8vo. [London] (1938). pp. 7, 100 pls. col.

This volume is the first of a work to be issued by the bodies named above. It takes the form of 100 loose pages, each giving four shades of the colour to which the page is dedicated.

At the head of each page in large letters is given the agreed name of the colour in English with its equivalents in the works of Ridgway, Repertoire des Couleurs, and Ostwald. A list of foreign synonyms is given and, where it is possible, a " Horticultural Example " is given. This last is intended to fix the colour. A history of each colour is appended, and a large black frame is supplied to cut out all except the particular shade under examination. The work is intended for use in all subjects where it is desirable that a standard be adopted and is therefore of great potential use in Entomology.

The first volume deals with the forms of Yellow, Red, Purple, Violet, Blue, and Green.

A LETTER FROM A. R. WALLACE TO F. P. PASCOE, WRITTEN FROM TERNATE, 20 DECEMBER 1860

Note by Professor HALE CARPENTER.

THIS letter is in the archives of the Hope Department of Entomology, University Museum, Oxford, to which Pascoe, influenced by Wallace, gave large collections of books and specimens.

Wallace stated in the Preface to *The geographical distribution of animals* that " the main idea . . . was stated . . . in the concluding pages of a paper on the ' Zoological Geography of the Malay Archipelago ' which appeared in the *Journal of Proceedings of the Linnean Society* for 1860 . . ."

MY DEAR MR. PASCOE,

Yours of January and March last were only received by me on my return here last month.

Many thanks for the papers you have sent me (the list of Longicorns of Australia I have not, however, received) and especially for your ideas on the subject of publishing genera and species. Your plan has removed a considerable weight from my mind, for the quantity of minute and obscure species in my collections were beginning to frighten me.

My collections now just packed are immense as regards specimens (above 13,000), but they are particularly poor in Longicorns and, in fact, in Coleoptera generally. There will be, no doubt, some curious and new things among the small ones, which are very numerous. They are from Ceram, Mysol, and Waigiou, and if you are taking to Homoptera you will find, I think, the largest collection of these you have ever seen.

The Geographical distribution of Insects in the Archipelago is certainly far less strongly marked than that of *Birds* and *Mammals*, but I think that it may be in a great measure imputed to the much greater liability of insects to accidental dispersion.

Still such cases as *Tmesisternus* and its allies strictly confined to the Australian region of the Archipelago, and *Collyris* almost equally peculiar to the Indian region, point to the same primary distribution in the one case as in the other.

More generally, however, the same genera have, I think, subgroups with a characteristic " facies " in each region.

Insects, moreover, are much more affected as to form by local circumstances than Birds and Mammals; thus the extreme general similarity in climate and vegetation between Borneo and N. Guinea has led also to a general similarity in the most prevalent insect forms, while the really close zoologic connection between Australia and N. Guinea is obscured by the very strongly contrasted physical features of the two countries being favourable to the propagation and development of distinct forms of insect life. Thus the ANTHRIBIDAE of the Indian region have increased and developed rapidly in the equally luxuriant forests of the Moluccas and N. Guinea, while in the arid plains of Australia they barely exist. On the other hand, the numerous MELOLONTHIDAE of Australia, favoured by the dry climate and numerous flowering shrubs of its plains, are unknown in the damp and flowerless forests of N. Guinea and the Moluccas, where also the more bulky forms of the Indian region have not been able to penetrate. Hence the excessive paucity of Lamellicorns in N. Guinea. The distribution of insects is, therefore, more obscure and complicated than that of the vertebrates. It was originally the same, but it is more rapidly affected by time and the accidents of distribution and differences of climate.

In haste,
yours very faithfully,
ALFRED R. WALLACE.

F. P. PASCOE Esq.

BOOK NOTICE.

Laboratory and field manual of Economic Entomology. (Revised.) By J. R. EYER. 4to. Ann Arbor (Edwards Bros.). 1938. pp. [iv] + 130. Price $3.75.

This book is produced by photo-lithography from an original typescript, and is printed on one side of the paper only.

It is presented in three parts: Part I. Insect Anatomy, Taxonomy and Metamorphosis. Part II. Control measures against insects. Part III. Field and laboratory studies of the more common insects injurious to crops.

The work is presented in a number of " Exercises " instead of the more usual chapters. Each Exercise is so worded that by following the instructions given a pupil may himself carry out the various directions as to dissection and study.

In addition to the exercises much of the work comprises series of questions. Formulae of many insecticides are given.

The single pages of the book are gathered into a " volume " by the use of a spiral wire linked through a row of holes along the back edge of the pages.

BOOK NOTICE.

The British Caddis Flies (Trichoptera). A collector's handbook. By Martin E. MOSELY . . . illustrated by D. E. KIMMINS. 8vo. London (Routledge). 1939. pp. xiii + 320, 4 pls., 631 figs. Price 21*s*.

This well-produced book is divided in three parts. Part I. Collecting, Preserving, Life-history, Structure, Classification. Part II. Inaequipalpia. Part III. Aequipalpia. There is an introduction by Mr. N. D. Riley, Keeper of Entomology in the British Museum.

The standard work on the Trichoptera of this country is that by McLachlan, which is long out of print and difficult to obtain. The present work will, therefore, fill a real gap in entomological literature.

The book is profusely illustrated, the very large number of figures being of wings in outline and genitalia.

Keys to the genera are given, and under each species is given a verbal description with other necessary information such as locality and place where it is likely to be found.

Details of the life-history where known are given in a special chapter, as are hints on preservation and collecting.

A series of pages is available for " Collector's notes," and the work is completed by an index.

ON THE OCCURRENCE OF DEÄLATED ♂♂ IN THE GENUS *DORYLUS* FAB. (HYM. FORMICIDAE)

By H. St. J. K. Donisthorpe, F.Z.S., F.R.E.S.

On 19 November, 1938, Dr. V. G. L. van Someren of Nairobi wrote to Sir Edward Poulton as follows ". . . I now send specimens of *Dorylus* which may be of interest. In the tube are larva and pupa of the male; and the pinned insects are wingless males which I took out of a 'trail' over a period of two weeks while the ants were on the move, November, 1937. I can find no record of wingless males, but of course it may be well known. It was the only occasion in twenty odd years in which I noted males taking part in a 'safari.'

" It would be of interest to know whether these males have *shed* their wings; or did they ever have them? I have dug out hundreds of male pupae as the specimens sent and all have wing cases, but of course, here again, the wings of some may never develop, though the case is present in the pupa."

Sir Edward handed the material to me and asked me to go into the matter. This I have done and the following short paper is the result. I have dissected out the genitalia and I found they are normal males in every way, except that they are deälated, the wings having been shed. Their correct name is *Dorylus* (*Anomma*) *nigricans* Ill. var. *molesta* Gerstäcker. I quote from two letters written to me by Dr. van Someren which give a little more information on his discovery. 17 December, 1938. ". . . When I referred to the males as 'wingless,' I presumed that they had shed the wings, and were, as you say, deälated. I had looked up such literature as we have and could find no reference to males taking part in a 'safari' or trek. On the other hand these ants are supposed to be nomadic, are they not?, and if this is correct both males and the female must surely, at some time, move above ground.

" I had the particular trail under observation during the daytime while the trek was on, but no female was noted; she may have travelled by night. In my garden of some 15 acres there are two *Dorylus* 'nests,' some 200 yards apart, and the movement seems to be from one to the other, at intervals (not checked), and when one is occupied, the other becomes vacant after a few days. Both are situated amongst the root system of large trees. It was from one of these 'nests' that I obtained the pupae of the various grades and the queen. The ants were *not* engaged in a raid, but in one of their periodical treks." Again on 18 January, 1939, he wrote: " I have examined the trails of *Dorylus* on several occasions lately . . . and there were no wingless males on the move. . . . One point I cannot make out is, why at odd times pupae of the soldier and worker grades are moved from one nest to the other. I have never seen male larvae or pupae being moved. Are there two queens, one in each 'nest'?". It is believed that there is never more than one queen in a nest, and when the ants move to a new nest the workers carry their large wingless queen with them. This probably accounts for the fact that some of the queens which have been found are minus some of their tarsi. The queens of *Dorylus* species are called "Dichthadiigynes" because Gerstäcker [*Stettin. ent. Ztg* **24**: 93, pl. 1, f. 2 (1863)] erected a new genus *Dichthadia* for the reception of a large female and which he named *Dichthadia glaberrima*. This is the female of the worker which Smith [*Journ. Linn. Soc. Lond.* **2**: 70 (1857)] had named *Typhlopone laevigata.* It is now placed in the subgenus *Dichthadia.* The males of the different *Dorylus* species are very well-known insects, often being taken at lights when flying by night. They are not entirely nocturnal, as their workers have been observed driving them out of the nests in large numbers in the daytime.

Linnaeus [*Mus. Ludov. Ulr.*: 412 (1764)] named the male of *Dorylus helvolus* "*Vespa helvola*" in 1764, and in 1767 [*Syst. Nat.* (ed. 12) **1**: 968 (1767)] "*Mutilla helvola.*"

It was not till later that the males of the different species of *Dorylus* (and also females) were recognised as such. In searching through the voluminous literature on *Dorylus* to try and find any mention of deälated ♂♂ I came across the following in *Proc. Acad. nat. Sci. Philad.* **1846–1849**: 200–201 :—

" In the letter transmitting his paper on Driver Ants to the Academy, Dr. Savage says, ' In the small vial you will find some specimens of *rubella*, with three very large individuals, which I consider the perfect insect. Now here is presented an interesting point of investigation, viz., the true relation of these larger individuals of the Driver Ants.' These specimens afford a solution to a problem which has engaged the attention of entomologists; namely, the relation of the Dorylides to the FORMICIDAE, since the large ones alluded to belong to the genus *Dorylus.* They are 13 lines long and seem to be referable to *D. nigricans, and they have cast their wings.*

" The circumstances attending the capture of these insects are thus stated by Dr. Savage.

" In the month of April, 1847, I visited the mission of the Am. Board Com. For. Miss., at Gaboon, 15′ north of the equator. Walking out at 7 o'clock on a cloudy morning, I saw a column of red drivers crossing the path. They consisted of two lines, as is always the case, one going, the other returning to their domicil. I stopped some time to compare them with the black species which abounds at Cape Palmas and that part of the West Coast generally. They were not as numerous or as large as *arcens*, but equally ferocious and offensive. Their arrangement and movements were the same. I soon discovered in the lines the large insects in question. I was here taken by surprise as I had observed nothing like them in the economy of the Black drivers. The first idea presented to my mind was, that they were captives, but on observing further they seemed to be no unimportant members of the community. Within a distance of about two rods I discovered ten of this class. I was soon convinced that they belonged to the Drivers, and proceeded to test the truth of the conclusion. I took one or two from the lines to a distance of six to ten feet. They seemed at once to miss their companions, and manifested great trepidation, and made continuous efforts to find a way of return. At last they reached the lines and at once resumed their places, displaying at the same time decided gratification. Nor were the lines thrown into any confusion by their entrance, as they would most surely have been in the case of a foreign insect or body. On further watching their motions I perceived that they did not continue on with the drivers, but after going a certain distance returned. This they repeated, going and returning. What office they performed I could not discover. My time was limited, not permitting me to trace them to their domicil. It was with regret that I left them, but from the observations made, it is evident that they were members of the driver community. I cannot doubt that they were the perfect state of insect. Several natives recognised them as insects that flew about, and into their houses at night. This is altogether probable when they first attain their winged state. Similar insects, closely allied to the *Dorylus*, it is known, fly at night into the houses at Cape Palmas, undoubtedly bearing the same relation to *arcens*, the Black Driver."

It will thus be seen that Dr. van Someren has made a similar observation to that of Dr. Savage. The only reference to this phenomenon that I can find in the literature is a short note by Wheeler, who wrote [*Ants* : 252 (1910)] : "The large males and females have been rarely observed in the nests. Savage saw a number of deälated males of *Anomma nigricans* marching in file with the workers. He endeavoured to divert some of them from their companions but they kept returning. This observation is of considerable interest because the males of all other ants show no ability to return to the colony or the nest, nor do they voluntarily accompany the workers on their foraging expeditions or migrations." It will be observed that Wheeler does not go into the question of the males being deälated, but only as to their behaviour towards the workers. Smith in "Observations on Ants of Equatorial Africa" [*Trans. ent. Soc. Lond.* (3) **1** : 470–73 (1863)] gives a number of extracts from Savage's paper but omits all mention of these deälated males. I will here make a digression on a small point of interest in Smith's paper. He states that he has had the opportunity to examine some specimens of an *Anomma* which were found in the skin of a large Gorilla lately imported into this country. I have found the ants in question : they are in the collection at the Museum, and are labelled "62.77." In looking up this number in the register I found that the skin of the Gorilla was sent to the Crystal Palace, and the ants were presented to the British Museum in 1862. Their correct name is *Dorylus* (*Anomma*) *emeryi* Mayr, subsp. *opacus* Forel. To return to the deälated males, in the collection at the Museum, there are seven deälated males of *Dorylus* (*Anomma*) *nigricans* Ill., three of *Dorylus* (*Dorylus*) *affinis* Shuck., and one of *Dorylus* (*Alaopone*) *atriceps* Shuck. I have little doubt now that these specimens were found by their collector in their present condition; but it seems curious that no note should have been made about them. I wrote to my colleague Dr. F. Santschi of Kairouan, Tunis, on the subject of the deälated males and he replied as follows :—

"Your letter of 12.xii.38 is very interesting on the subject of apterous males of *Dorylus*. It would be necessary to examine if the anatomy of the sexual organs is normal. I think that it is a question of individuals in which there is a predominance of the female hormones exciting the psychology whilst the soma remains under the influence of the male hormones, at first predominant and then neutralised later by the female hormones. I put forward this hypothesis by simple analogy with that which one sometimes sees in *Homo sapiens* L. This explains the worker-like behaviour (marching in file with the workers and returning to the nests) of these apterous males. The loss of the wings is also characteristic of a psychological female act, as the fertilised female loses her wings."

The most interesting questions appear to me to be—why are certain males deälated ?, only a few out of the vast numbers reared. Do they shed their wings themselves ?, and when ? The courtship between *Dorylus* males and the heavy blind wingless female must take place in the nest. Are the deälated males the successful suitors ? ; as, of course, all those males which have flown away, or have been driven out by the workers, cannot have encountered the female.

These questions seem to offer a large field for future investigations.

BOOK NOTICE.

An Introduction to Modern Genetics. By C. H. WADDINGTON. 8vo. London (G. Allen and Unwin), 1939. pp. 441, 5 pls., 159 figs. Price 18*s.*

This book is arranged in five parts entitled: Formal Genetics; Genetics and Development; Genetics and Evolution; Genetics and Human Affairs; The Nature of the Gene; and these are followed by an Appendix on laboratory methods for classwork on *Drosophila*, a bibliography and author index, and a subject index.

The aim of the book is to give an up-to-date account of the main principles of genetics, special attention being paid to the way genetics overlaps other fields of research. It is particularly arranged to suit students whose previous knowledge of genetics is small and for this reason special regard has been given to the inclusion in the bibliography of works which may act as guides to further studies and which give literature lists for this purpose. The bibliography, although it extends to 26 pages, does not claim to be exhaustive. The author urges the connection between genetics and other branches of biology such as cytology, embryology, the study of evolution, and the biochemical nature of cell constituents, and states that the connection is close and that the boundaries between the subjects deserve far less attention than they receive.

BOOK NOTICE.

Die Flöhe. Bau, Kennzeichen und Lebensweise, Hygienische Bedeutung und Bekämpfung der für den Menschen wichtigen Floh-Arten. Von F. PEUS. (Hygienische Zoologie, Band 5.) 8vo. Leipzig (Verlag Dr. P. Schöps). 1938. pp. v + 106, 29 figs. Price RM. 4.80.

This booklet is an exhaustive treatise on fleas of importance to man. It is divided in four parts: Morphology and Systematics; Life-history and development; Hygienic importance; and methods of control. A list of literature is added.

Much of the book is devoted to the determination and description of the fleas important to man, and the long key to the characters of use to identify specimens is accompanied by many figures. Early stages of some of the species are also depicted.

In the section devoted to control, formulae are given for several of the chemical preparations recommended. Stress is laid on the necessity of personal cleanliness in the control of fleas.

BOOK NOTICE.

Faunistischer Führer durch die Coleopteren-Literatur. Von S. SCHENKLING. Band 1. Europa, Lieferung 4 (pp. 193–256).

This, the fourth part of the first volume, continues the great bibliography of the Coleoptera by Schenkling.

The part contains the completion of the literature relating to Russia, and details that relating to the following areas: Poland, Carpathia, Central Europe in general, Czechoslovakia, Hungary, the Alps in general, Switzerland. In the English spelling of the names of some of these an unorthodox style is used, viz.: Alpes and Carpathien.

That part of the book most likely to be used by British readers is still to come. It is to be hoped that its appearance will not be long delayed.

CEPHALIC GLANDS IN THE CORIXIDAE (HEMIPT.)

By C. J. Banks.

Communicated by R. E. Hall, F.R.E.S.

Several investigators have studied the anatomy of the head in the Corixidae (Ekblom, Geise, Hungerford, Weber), but none of them has mentioned the presence of the pair of glands here described. Most of their work was confined to the study of the mouth-parts and associated structures, but it is surprising that these organs should have been overlooked.

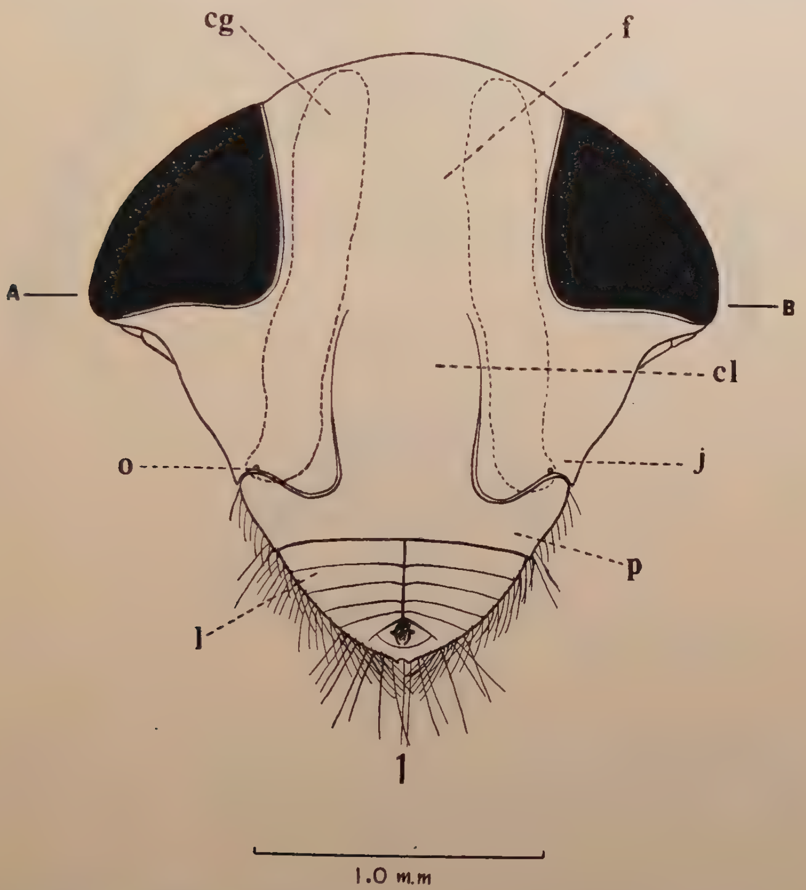


Fig. 1.—*Sigara striata* (L.). Head from the front, showing the position of the cephalic glands.

cg = cephalic gland, cl = clypeus, f = frons, j = jugum, l = labium, o = opening of left cephalic gland, p = paraclypeal lobe.

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The glands may best be seen by removing the head of a Corixid, dehydrating and clearing it, and examining it by transmitted light while still in the clearing agent. As viewed from the front, a gland appears as an elongated, semi-transparent organ extending from the region of the vertex close to the inner margin of the eye of its side, to the jugum (Snodgrass 1935 : 331). At the juncture of the jugum with the lateral extension of the clypeus (paraclypeal lobe), the gland opens at a minute pore. The external openings of the glands are difficult to see in mounted specimens. It is best to look for them in dry, recently killed insects, and with reflected light. They may then be discovered lying in very small depressions in the surface of the cuticle.

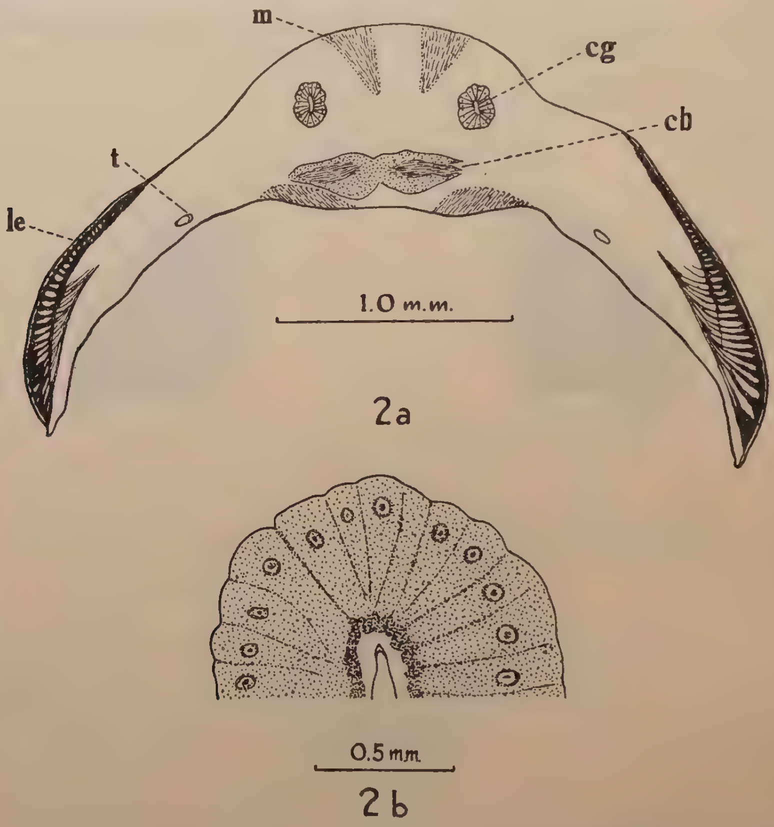

Fig. 2.—(a). *Corixa punctata* (Illig.). Horizontal section through the head (semi-diagrammatic); (b). Part of a transverse section through a gland, enlarged.

cb = cerebral ganglion, cg = cephalic gland, le = left eye, m = pharyngeal muscle, t = trachea.

Within the head, each gland runs close to the pharynx, and is anterior to the cerebral ganglion, to the stylets, and to the lever mechanism of the mandibular stylet.

Each gland is of approximately uniform thickness throughout, and there is no visible duct.

The position of the glands in the head is illustrated in fig. 1, which represents the head of a male *Sigara striata* (L.) viewed from the front. The outlines of the glands are represented by broken lines; the various parts of the head are also labelled. Fig. 2 shows a horizontal section through the head of a last instar nymph of *Corixa punctata* Illig. This section would pass approximately through the line A–B in fig. 1. In this section, the glands are prominent structures which stained deeply with haematoxylin. In transverse section each gland is nearly circular and possesses an elongated lumen. The cells are of a columnar type, with large nuclei and a finely granular cytoplasm, except at the inner edge where the granulation is coarse. The lumen is lined with a thin layer of what appears to be cuticle, presumably secreted by the cells (cf. fig. 2b, which represents an enlarged portion of a transverse section through one of the glands). If this is true, it would suggest that the glands are of ectodermal origin.

The following species of CORIXIDAE have been examined; in all of them the glands are present. *Corixa punctata* (Illig.), *C. panzeri* (Fieb.), *Sigara sahlbergi* (Fieb.), *S. distincta* (Fieb.), *S. striata* (L.), *S. concinna* (Fieb.), *S. praeusta* (Fieb.), *S. scotti* (D. & S.), *S. lateralis* (Leach), *Cymatia bonsdorffi* (C. Sahlb.). In *S. striata*, the glands seem to be relatively longer than in other species. It would seem that these organs are present in many, if not all, of the CORIXIDAE. They are present in both sexes and in the nymphs.

The glands are not salivary in function, as they are in no way intimately connected with the organs of ingestion. It is possible that they have a repugnatorial value, but, as yet, no secretion has been observed in living insects.

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BOOK NOTICE.

Die tierischen Parasiten des Menschen. Von Dr. W. STEMPELL. 8vo. Jena (Verlag G. Fischer). 1938. pp. viii + 226, 219 figs. Price 12.00 Rmk. (Bound 13.50 Rmk.) less 25% to purchasers outside Germany.

This book is addressed in the first place to medical men interested in, or concerned with, the animal parasites of the human body. For this reason it is written with the minimum of technical language. It is also intended for the Zoologist, who has at present no other similar work in the German language.

There are six sections to the book: general introduction on parasitism; the animal parasites of man; list of parasites arranged by the location in which they may be found in the human body; list of the more important literature; additions; index.

The main part of the book is that dealing with the parasites, and this is arranged by Orders of parasites, commencing with Protozoa and followed by Vermes and Arthropoda, including Insecta.

By far the larger proportion of the species dealt with are figured, and the figures are largely original or have been redrawn, using actual specimens as guides. Less important parasites are described in smaller type to save space. Short accounts are sometimes added showing means of control of the parasites.

The whole of the book is printed on coated paper.

Book Notice.

Alphabetisches Artregister der umfangreichen Genera im Catalogus Coleopterorum Regionis Palaearcticae, von A. Winkler. Zusammengestellt von Adolf Gassner. Parts A–F. 8vo. Wien (A. Winkler). n.d. pp. 349.

These six parts form a complete species index to the well-known "Winkler Catalogue" of Palaearctic Coleoptera.

The index is arranged in systematic order by families and in the families by genera with alphabetic indices to the species. The work is not printed but reproduced by a system of duplicating and is handwritten. Three columns are given on each page and a list of contents is given for each part. The format of the book is that of the original catalogue.

Book Notice.

Die Naturgeschichte der Tagfalter unter besonderer Berücksichtigung der palaearktischen Arten. Von G. Lederer. Teil 1. (Handbuch für den praktischen Entomologen Band II, Tagfalter 2te Auflage.) 8vo. Frankfurt a.M. (Verlag O. H. Wrede). n.d. pp. 160, 3 pls., 81 figs.

This book is issued by the Internationaler Entomologischer Verein as a special publication and at the same time as a volume of the Handbook for practical entomologists.

The book gives a general introductory chapter on the Rhopalocera and this is followed by two special chapters devoted to the PAPILIONIDAE and PIERIDAE respectively. The author is in charge of the famous town aquarium at Frankfurt, where extensive breeding experiments have been carried out with large numbers of insects.

The treatment of the families is described in detail and much information is given on pairing, egg-laying, larvae, parasites, diseases, food-plants, pupation, and imagines. Many illustrations are given of the habitat of the various species described and of the species concerned. The illustrations are often from photos made under natural conditions.

Book Notice.

Butterflies and Moths of the Wayside and Woodland. Compiled by W. J. Stokoe, based upon the standard works *The Butterflies of the British Isles* and *The Moths of the British Isles*, by R. South. 8vo. London (F. Warne & Co., Ltd.). 1939. pp. vi + 309, 71 pls. col., 25 text figures. Price 7*s*. 6*d*.

In this volume the contents of the well-known three volumes of South are compressed.

"Technical terms . . . have been avoided as far as possible, the main object being to provide a reliable guide to the easy identification of our Butterflies and Moths, together with a clear account of the whole or part of the various stages of their existence."

It is doubtless for this reason that all the species are indicated by their popular names in large black type, with the scientific name in small type below. It may be noted that the Nomenclature of British Butterflies is that adopted by the Royal Entomological Society.

In format the book is identical to the original work of South and could be carried easily in the pocket.

PUBLICATIONS

The Publications of the Royal Entomological Society are *Transactions* and *Proceedings*.

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A uniform method is adopted for the citation of bibliographical references in the Society's publications as follows:

> Smith, A., 1936, New species of Coccidae, *Proc. R. ent. Soc. Lond.* (B) **6** : 301–306, pl. 1.
>
> ——. 1936, New species of Coccidae, *Trans. R. ent. Soc. Lond.* **84** : 901–936.

Titles of periodicals cited are to be abbreviated in the manner indicated in the *World List of Scientific Periodicals, 2nd edition,* 1934.

Authors are entitled to receive 25 copies of their papers free of charge and may purchase additional copies provided that request be made before publication.

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Papers of less than eight printed pages (approximately 7000 words) will not normally be accepted for the *Transactions*, and papers by authors who are not Fellows of the Society must be communicated by a Fellow.

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As from January 1936 the journal *Stylops* is continued as *Proceedings Series B. Taxonomy.* Copies of volumes 1–4 are available at *£1 16s. 0d.* each, post free.

MEETINGS

TO BE HELD IN THE SOCIETY'S ROOMS

41, Queen's Gate, S.W.7

1939.

Wednesday,	October	4	6.0 p.m.
,,	,,	18	8.0 p.m.
,,	November	1	6.0 p.m.
,,	,,	15	8.0 p.m.
,,	December	6	6.0 p.m.

1940.

Wednesday,	January	17	8.0 p.m.	(Annual Meeting)
,,	February	7	6.0 p.m.	

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